



**The Everett Interpretation of Quantum Mechanics.
Collected Works 1955-1980 with Commentary, by Hugh
Everett III, ed. by J. A. Barrett and P. Byrne
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The Everett Interpretation of Quantum Mechanics. Collected Works 1955-1980 with Commentary.
By Hugh Everett III. Ed. by Jeffrey A. Barrett and Peter Byrne.

This book is essential reading for anyone interested in the Everett interpretation of quantum mechanics, and in particular in Everett's own work. Recent years have seen a huge interest in Everett's theory, both from the point of view of new developments within an Everettian framework, and from that of the history of the theory and the biography of Everett. The first kind of developments have included the recognition that decoherence can play a crucial role in Everett's theory (as argued especially by Hans-Dieter Zeh, Simon Saunders and David Wallace); and the flurry of work on probability in Everettian quantum mechanics (in particular the decision-theoretic approach advanced by David Deutsch and David Wallace), and the intense debate it sparked. The second kind of developments have included the details of the genesis of Everett's theory against the background of Wheeler's doomed attempts to obtain Bohr's blessing for it (first investigated by Stefano Osnaghi and co-workers); and the exhumation of Everett's papers from his son Mark Everett's basement, including Everett's drafts of his thesis, notes, and correspondence relating to the Bohr-Everett-Wheeler affair and the later reception of Everett's work, which together with further biographical research led to Peter Byrne's arguably definitive biography.

This volume, edited by Jeffrey A. Barrett and Peter Byrne, is a commented edition of Everett's published works on quantum mechanics, of transcripts of comments and conversations by Everett, and of a fascinating selection of notes and other materials mostly from Mark Everett's basement, with three introductory chapters and extensive commentary and footnotes. It provides the opportunity to read a variety of the sources behind the recent historical narratives on Everett (the originals are available in an on-line companion archive at UC Irvine, under the address <http://hdl.handle.net/10575/1060>). Further, it gives access to Everett's original theory in its fullest form (who has read Everett's 'long thesis', or even his 'short thesis' within the last ten years?), including the entirety of the extant clarifications provided by Everett, especially in reaction to early misunderstandings of his theory, including by early champions like Bryce DeWitt.

The book starts with three introductory chapters, one general, one biographical and one conceptual (Chapters 1-3): the Conceptual Introduction is especially interesting as a guide to understanding Everett's texts. There follow three 'minipapers' sent by Everett to Wheeler in the initial stages of work on his thesis, and a related letter by Wheeler to Everett (Chapters 4-7) – Wigner's friend and splitting amoebas looming large. Chapters 8, 9 and 10 are the long and short versions of Everett's thesis (as published in DeWitt and Graham's epochal collection and in *Reviews of Modern Physics*), and Wheeler's short article that accompanied publication of the latter. In reading the long thesis, one is struck by Everett's sheer genius and surefooting, by the elegance of his presentation, and by the richness of details and ideas, many of which seem ahead of time and get lost in the short thesis. Examples are Everett's chapter on information (80-95), his full discussion of composite systems and relative states (97-103), his clear statement of no-signalling (99), the informational treatment of the uncertainty principle (110), the lucid understanding of typicality, much earlier than one would expect from modern discussions (123-130), the treatment of approximate measurements, which also anticipates today's measurement theory (145-148), the stab at Bohr on quantum jumps (151), and the insightful and up-to-date discussion of alternative approaches to quantum mechanics (151-159). There follows some fascinating correspondence about the Bohr-Everett-Wheeler interaction and the early reception of the thesis (Chapters 11-18). Of particular note are five documents from

May/June 1957: Wheeler's notes of his conversation with Bohr's assistant Aage Petersen (207-210) ('AP [... s]ays Von N[eumann] & Wig[ner] all nonsense...'), and his letter to Alexander Stern (219-222), in both of which one sees how strongly and insightfully Wheeler supported Everett's ideas, at the same time thinking they were compatible with the Copenhagen interpretation; and Everett's letters to Petersen (who was a personal friend, 238-240), DeWitt (252-256) and E. T. Jaynes (261-264), in which Everett makes very explicit remarks, respectively, about the Copenhagen interpretation, about branching and the relation between theory and reality, and about the role of Lebesgue measure in classical statistical mechanics. (I believe this letter to Jaynes may prove very significant to clarifying both Everett's views on typicality and the background role played by the concept of information in his theory.) Chapter 19 is an equally fascinating transcript of discussions of Everett's theory at a 1962 conference at Xavier University (where Boris Podolsky was based), followed by more notes and correspondence by Everett from the years 1970-1980 (Chapters 20-22 and 24-25), in particular Everett's marginal notes to the original preprint of John S. Bell's "Quantum Theory for Cosmologists" (including one referring to branching going '*either way*' in time, 287), and a letter to Max Jammer (294-298); and a tape recording of Everett and Charles Misner reminiscing together in 1977 (Chapter 23). A number of appendices (317-366) reproduce handwritten drafts and notes in Everett's thankfully legible hand. A final note, bibliography and detailed index conclude the volume (which is beautifully produced, except for a number of rather irritating misprints).

It is a well-known fact that Everett has often been read as obscure, or at least not quite satisfactory on a number of points, in particular on what Barrett in the Conceptual Introduction calls the 'determinate record problem' (less accurately 'preferred basis problem') and the 'probability problem'. Indeed, these perceived problems have originated some of the most interesting (and/or controversial) recent developments in philosophy of quantum mechanics. This volume offers a unique opportunity of reconsidering Everett's original theory on its own merits. The editorial introductions and notes are of great help in this regard. Indeed, Jeff Barrett is arguably the most insightful commentator of the 'true' Everett (cf. also his papers quoted in the bibliography). From the following remarks, it should be clear that a historically accurate reading of Everett may usefully inform our current philosophical concerns. In such an integrated HPS perspective, the most interesting complex of problems connects the 'determinate record problem', 'empirical faithfulness' and the 'probability problem'. Everett clearly thought that any state can be picked to define states relative to it; *some* systems, however, have a complex enough structure that they can store (and perhaps act upon) memories of the relative states of systems they have interacted with in certain (measurement-like) ways; and the theory will be empirically *successful* if it predicts the standard quantum statistics for *typical* memory sequences of these observer systems.

As to determinate records, the stability of memories is coached in the language of successive observer states (118), and it is explicit in Everett's discussion that quasi-classicality is aimed in part at elucidating aspects of observer systems (137). (Note that classicality is a central feature of observation according to the Copenhagen interpretation!) Technically, Everett relies on Ehrenfest's theorem (136-137), which we now know is not sufficient to ensure quasi-classicality. Nevertheless, I would argue the spirit of his discussion is the same as that of Everettians like Saunders and Wallace who use decoherence to select the diachronically stable structures ('worlds') whose content ('records') is required to match the world of experience (cf. 46-50, and footnote bw on p. 137).

As to empirical faithfulness, it is what Everett uses to characterise an empirically satisfactory theory (additional non-empirical factors such as simplicity, comprehensiveness, picturability, etc., further influencing theory choice). Although Everett devotes the second appendix of his long thesis to discussing the role of physical theorising (168-172), Everett's comments there are somewhat compressed, and Barrett tries to elucidate the notion in some detail (see esp. 50-54, and Barrett's papers). Everett is perhaps most explicit in his letter to DeWitt. He is clearly an empiricist of some sort, but the form of empirical adequacy he requires is: 'one accepts or rejects [a theory] on the basis of whether or not the *experience which is predicted by the theory* is in accord with actual experience' (253-254, Everett's emphasis). This takes full account of the fact that it is the theory that tells one what one can observe. Let me note a parallel with another empiricist approach to quantum mechanics, Van Fraassen's 'modal interpretation', in which any vector featuring in any arbitrary convex decomposition of the density operator of a system counts as a possible property of the system. The set of these possible properties is the same as the set of states of the system relative to states of the rest of the universe; and the analogue of the 'determinate record problem' in the modal interpretation also spurred a flurry of further work in the 1990s (although arguably less successful than the recent work on Everett). Barrett also attaches great importance to the correspondence between theory and reality being partial (e.g. in the comparison between Everett's understanding of his theory and DeWitt's, cf. footnote iu on p. 250).

Finally, as to the probability problem, Everett's aim is to formulate 'wave mechanics without probability' (as his long thesis was originally titled, 17), basing instead his discussion on typicality (123-130 and 190-192). For him, this is a non-probabilistic notion (although one can use measure theory to define it, cf. also footnote dx on p. 191) that is basic even in classical statistical mechanics (cf. Everett's remarks to Jammer, 294-295, and especially his letter to Jaynes, 261-264). One may criticise the naturalness of the axioms employed by Everett in his derivation of the norm-squared measure as measure of typicality (but then, one may criticise also the naturalness of the Deutsch-Wallace decision-theoretic axioms). But with respect to whether the typicality approach *makes sense* of our use of probability in quantum mechanics, I believe Everett's own approach deserves closer attention than it has standardly received.

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